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## Frederick T. Rall Jr.: The Cold War Aerospace Technology History Project (Interview 2)

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Frederick T. Rall

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Frederick T. Rall, Jr.

## Interview 2

Cold War Aerospace Technology History Project



Interview Conducted and Edited by Gino Pasi  
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Oral History Project

Project: Cold War Aerospace Technology  
Interviewee: Frederick T. Rall, Jr.  
Interviewer: Gino J. Pasi  
Transcriber: Gino J. Pasi  
Interview Date: 31 August 2007  
Interview Place: Studio A, Center for Teaching and Learning, Wright State University  
Transcript Edition: Edited

Start of Video Tape 2

00:00:00 Pasi: Again, today is Friday, August 31, 2007. This is part two of our interview this morning with Mr. Frederick Rall. Mr. Rall when we left off you were talking about the B-70 program and the B-70 was a plane that never made it out of experimental stage. Is that correct?

00:00:47: Rall: That is correct.

00:48:00 Pasi: That sort of brings up the question as far as cancellations of programs; was that something that happened due to performance issues, or financial issues, or maybe even political issues at times? Could you maybe discuss that?

00:01:07 Rall: I think it's a combination of all of the above. One of the very first programs that I remember which ever really made it to the way it was supposed to was the X-3 program. The X-3 program was supposed to be a Mach 2 airplane, research airplane, built by Douglas, Santa Monica. It produced loads and loads of great research, wind tunnel tests results, I mean just beautiful kinds of data. The engine really never developed for it. And it may have flown but I mean it never did what it was intended to do as far as actual flight was concerned. But it produced a massive amount of very good data.

Navajo was a SM-64 was supposed to be a Mach 3, ram-jet powered vehicle. Did lots of wind-tunnel testing on it. Had a turbojet powered prototype called the X-10 which was remotely controlled test vehicle. Navajo never made it into production, although they did lots of test on the engine. It would it have run, but I think survivability eventually became a question as to whether or not the ground-air missiles of the Soviet Union would be able to pin it.

In fact that's one of the things that killed the B-70 program was the thought that the airplane might not be survivable against the Soviet Union because of their

ground-to-air missile threat. But there are lots of programs that were going to be cancelled.

F-103 was going to be a combination turbojet/ramjet airplane. It was tested full-scale down at Tullahoma, but it never made it off the drawing board into a piece of hardware. But that's just part of the game. You don't get invested in individual programs except when you're directly associated with it. For instance I was associated with the B-70 program and I hated to see that airplane not go on. But at the same time I was working the B-70, I had been invited. Invited is the wrong word. I was [laughs] told to get involved with the SR-71 program which in essence replaced it. That was sort of interesting. My first trip to Washington D.C. in an official capacity was on a Saturday morning reporting to the Department of Defense, not the Air Force, but the Department of Defense people. I had been tasked to evaluate what the drag of the B-70 was at its cruise Mach number of 3.0. So I went back and I put together what we did back then which was grease pencil charts, and put together the whole series of them and took them back together with my boss, General Ascani, and a few other people. And we sat down on Saturday morning and briefed them. And I went back home and a few days later during work I was told to report down to building number "umpty-ump," and I was introduced to the Program Director of the SR-71 program. There's no sign on the door; everybody looked at you when you walked in the door suspiciously. And I was told I was going to be given a task on this classified "black" program to do something. So I said "well that's fine." They sent me out to Edwards Air Force Base. I reported in to a hangar, large massive hangar at Edwards, absolutely black except down at one end of the hangar with a spotlight shining on him was a Colonel sitting behind this desk [laughs] and a chair in front of the desk. I mean it was like a movie almost. And I walked down and introduced myself to the Colonel, and sat down and he then proceeded to tell me that I was being introduced to the SR-71 program; and he told me what it was and that I was being asked to evaluate what the drag was at its cruise Mach number.

As far as I know the cruise Mach number on that airplane has never been declassified so I won't say it. And so I went out to the—the next day—out to the—I was told where the "Skunk Works" were in Lockheed in Burbank—now it's well-known by satellite pictures and the like—and sat down and was given a set of drawings on the SR-71 that I went through and calculated what the drag was. Then handed that report in to the SPO and they sent it on, and it turns out that the Department of Defense was interested in comparing what the lift-to-drag ratio was of the B-70 versus the SR-71 to see whether or not their decision to go ahead with SR-71 and drop the B-70 was correct. I mean I didn't know that that

was what they were doing at the time, and all I did was just keep my nose to the grindstone and do the work that they asked to be done. But after I had done that job they continued to ask me to consult with them on various aspects of the SR-71 program and so I did.

And it's sort of interesting; "black" programs have many, many, advantages from an engineer's point of view. You have less people trying to interfere with the program. You have clear-cut directions as to what it is you want to do. You can make quick decisions. You don't have to go through twenty layers of command in order to get a decision made—very, very, very efficient way of doing it, and a technique which was modified slightly by General Bellis when he became Program Director on the F-15 program. But that's a whole different story.

As I said earlier Cal Hargis and I had worked together in the Aircraft Laboratory and when I was in the B-70 program. His wife filed for divorce and his wife suggested that he should move in with me. And so I was still a bachelor; I was interested in work and I was working probably sixty, seventy, hours a week just routinely because I enjoyed doing it. And so we got an apartment together and he was then at that time—he was chief engineer on the Dyna-Soar program and I was head of aerodynamics on the B-70 program, we got to talking. Well earlier Cal had gone to the Sloan program at M.I.T. And of course sitting around having little "BS" sessions he kept telling me how good the Sloan program was and how he got to learn a lot of things, and meet a lot of people and see outstanding things. So I said "well if he can do it well I can do it to," so I applied to go to the Sloan program, for the Air Force to send me there. The Air Force is really good in giving you education. I mean they had sent me to a lot of short courses over the years and the like. Well the first year I applied I didn't make the grade. But the second year I applied I did make the grade and I got a Sloan Fellowship.

00:09:45 Pasi: To M.I.T.?

00:09:47: Rall: To M.I.T. yes.

00:09:50 Pasi: And again that was another master's degree?

00:09:53 Rall: That was another master's degree, this time in Industrial Engineering. Although they call it an M.S., it's still in Industrial Engineering—a Course 15 there. It's not the normal Course 15 program; it's a calendar-year full. It was sort of very educational program. The first two weeks that we were there—and these are people from all over, from contractors, Navy, Army, individuals—the first two weeks we participated in what we're called T-groups. I doubt T-groups are a known quantity these days, but T-groups back then was approximately twenty

people were put down in a room all day with no structure. And so for five days a week, for two weeks, we were sat in the room with twenty other people with nothing to do. That is an interesting experience—[laughs] develop—to see how the personalities develop, the leadership, the conflicts that develop. “I think we ought to do this.” “No, we don’t want to do that.” And “you’re just saying that because--” very, very interesting.

00:11:22 Pasi: Today they would make a T.V. show out of that.

00:11:26 Rall: [Laughs] Some of it was extremely brutal. We had two Indians; these are India Indians in the group, different caste. You wouldn’t believe the conflict that exists between the castes; it’s just really, really, tough. Some people would try to mend the conflict and other people would just promote it, a real lesson in human interaction. After that they sat us down and [laughs] asked us to examine it and we went through and started the regular training.

00:12:12 Pasi: So this training was then more for management of people?

00:12:15 Rall: Absolutely management. These are for engineers set up for Alfred P. Sloan, who is a known quantity in this area, so that the engineers could become reasonable managers. The course was set up—there were some courses during the summer time in which you were accurately graded. These were fundamental courses in economics, and statistics and the like—some elements of change, teaching. And in the fall and spring semester it turned into a much, much, more general kind of learning experience. Each week a industry member, or a military member, would be invited to attend after-hours, and he would talk and just say what he wanted to say about that. And we were asked questions, and we were given courses on how to ask questions. We were given courses on how to act during cocktails. And of course we’d have drinks after the general meeting with people and sit around in the faculty club, and discuss things over a martini, or two, or three, or four as the case may be depending on how things went. We—also—Boston was a fairly high price of liquors—store and the Sloan program had its own bootlegger as a matter of fact; so we could get cheap liquor. We were told to have parties and everybody had to have a party at their house, or turn one on and so it was a very, very socially oriented kind of experience.

00:14:34 Pasi: To build up those social skills?

00:14:36 Rall: Absolutely, absolutely. And taught at the same time the philosophy of management. Oh I forgot what they call it now, but the idea was that—oh I can’t

think of the name of one of the famous academics in the area—but the general idea of management was theory X or theory Y. In one you were a boss and you told your people like a dictator this is what you wanted to do and if you don't do it I'm going to beat you over the head. Or let's sit down and say you look at this; this is what in the long run is going to help us both, and we've got to have this done; do you have any suggestions on how to do it? And if we do it this way we can share in the rewards from this kind of thing. And that really, really, impacted the way I started to think about life because my background had been in—my parents were all from German grandparents. They spoke German and I mean that Teutonic kind of mentality, and of course rubbed off on me and so [laughs] I was tempted to say to people who worked for me “this is what you've got to do and by god if you don't do it there's something wrong.” I soon learned that that was not an appropriate way to get the best response out of people. And that people really wanted to do well just given the opportunity to do it, and that really modified the way I thought about how to deal with the workplace. That was really a learning experience.

We took several trips; we went to New York City and met with Watson from IBM. And I mean we met with the highest level financial people in New York City. We took a European trip; met with the Chancellor of Germany. We went to Italy; went to England. I mean by the time you got done with that course your head was so blown up because you had been associating with so many high level people that you thought that that was just absolutely normal. And it took you about six weeks to get back to normal to understand that life back here was a little—was—different than [laughs] life there. But the impact was really severe and well worthwhile.

Later on in my life while I was Tech Director, I managed to get an engineer almost every year into that Sloan program either at M.I.T., or at Stanford, and they eventually became SESs, Senior Executive Service Members, Super Grades. A really important thing to keep the work force well-trained and progressing.

00:18:01 Pasi: It sounds like a great opportunity that you established for others as well.

0018:04 Rall: Yeah, it was. Really was. Really was. When I came back from the Sloan program, I went back to the B-70 and stayed there for about six months, and the first flight was coming off on the B-70 when I came back. I spent six weeks out at Edwards Air Force Base getting the air plane off the ground. It had some teething problems; it had a 4000 PSI, pounds per-square-inch hydraulic pressure system. And the classical hydraulic systems were 3000 PSI. The stainless-steel tubing for that hydraulic system was cracking, and that was not good because that

controls the flight control system. And you can't fly; I mean you'd crash if that happened in flight—dangerous. So they had to fix it somehow or other. I knew that the SR-71 had followed the B-70 around doing some contractors and that the B-70 would go give a contract to do certain things, like build a hydraulic pump, and that shortly thereafter the Lockheed guys would come around and say “now you've got this contract now with the B-70; how about if you did so-and-so with us; we could get it on the cheap.” And that's how Lockheed got a lot of things done at a relatively low cost. And so I went to—called—up the SR-71 SPO Director back at Wright Field when I was out at Edwards and asked him if I could get North American, who was building the B-70 program, to go to Lockheed to discuss the hydraulic system with them and they said “ok.” But they didn't want the North American individual [laughs] that I recommended who was head of sort of the engineering aspect of the B-70, but they'd accept somebody else—a little personal conflict they exhibited in that situation and I said “fine.” So—we—I took that North American individual over to the Skunk Works and sat down with them. And Kelly Johnson had his “pound of flesh” with the North American guys. Kelly was that kind of individual—great guy. But they eventually got down to the working level of the hydraulic system. And the North American individual came back out the next day, and they had put an order in to put ripple dampeners in the hydraulic system in the B-70, when they showed up shortly thereafter, and that solved—fundamentally solved—the problem [laughs] on the hydraulic system breaking. And then we got the airplane off the ground and flew.

Well all of the fun part of the development program had been gone then for me, so when I was called up by the F-111 program chief engineer to come down and look at the job that they had down there; I said “ok” I'll go down there and look. The F-111 hadn't quite flown yet, but it was an interesting airplane. It was a swing wing airplane. It was sort of the first airplane that had switched patterns of what was important in aircraft design. The pattern in aircraft design has gone from—the first thing that was important was speed and altitude. The search for speed was always there. First you go transonic, supersonic, mach 3, and whatever you could do. And then when they, Russians, started showing missile—ground-to-air missile—capability they began to worry about survivability. So the F-111 was the first real aircraft that began to address the survivability problem by going out at low altitude, 200 feet at Mach one point two, and saying that you know “that's going to make the airplane survivable.” And so I said “ok I'll go down.” Well it turns out the job they offered me was the Head of the—oh I forget what they called it—the Flight Dynamics or something Division or Branch—

00:22:48 Pasi: Chief of the Aeromechanics Division?



00:22:49 Rall: Aeromechanics Division, right—in which was responsible for the external and internal aerodynamics, and the stability control and flight control. The bad part about it was that I was replacing an individual who the Chief Engineer wasn't happy with. And this guy was a nice guy who I had known for years and years, and years. And who had established a long term relationship with the people that I would now be boss of. So when I walked in I knew I was going to have a problem in human relations because here I was replacing a guy who they just dearly respected and liked. And some young "whipper-snapper" comes walking in and tries to take over his job.

One of the great rewards, to jump ahead for a second that I got was when I finally left the program, that F-111 program. Those same people did something which they didn't have to do. [Pauses, sighs] They gave me a Snoopy model—[pauses] ah!—with helmet and goggles, and stuff, and a plaque; I can't remember what the plaque was, but what it said was that they were happy to have—to have me been there and really appreciated working with me. I really cherish that. I cherish that a lot more sometimes than the ordinary presents or rewards that the military gives you because it's just you live long enough to get them. Excuse me. [Wipes his eyes] Didn't know I was going to get emotional.

But the F-111 turned out when I got down there to be a very interesting program. I went down to Fort Worth for the first flight which was occurred just several weeks after I got there. And the engine stalled on the ground before the airplane took off. And it then went through flight-test programs and the engine stall problem got worse up in the air. And that was a major, major, major, problem because the F-111 was being touted as a multi-national; it was being bought by the Australians, multi-service; it was being bought by the Navy. So to have technical difficulties on the airplane was of major concern to the Department of Defense.

The contractors tried several things; the engine manufacturer tried to increase the stall margin on the Pratt & Whitney engine—TF-30. The airframe manufacturer didn't do very much except to conduct different kinds of tests and just wasn't making any progress. And this was a subject of course which was very close to me because I had worked with this for many, many, years, this general topic. And so I kept pressuring the contractor for running some tests and wind tunnel test, and examining what the inlet looked like, and get some data out of them. I had very little success in getting data out of the contractor, but finally, in what is not

too un-typical a response, rather than giving me the data I wanted they gave me a thousand times too much data so I'd have to go through and sort out all the data, and of course I couldn't do that, so I didn't. I got upset with them and I noticed that they were running this series of wind tunnel tests on the inlet down at Tullahoma Tennessee in the propulsion wind tunnel. And my boss had not—wouldn't—let me go down to Tullahoma to work with the contractor down there. But one day he was TDY someplace, temporary duty off base and so I wrote him a note; said "I went down to Tullahoma to work with [laughs] the people." So on my own I picked up and went down to Tullahoma. I got down there and the contractor wanted to know what the hell I was doing down there. And so I told him I was down there to help. Famous last words, you know here's a government guy comes around to help. [Laughs] But I got to know the people; I had known some of them before working on other programs. And eventually we came around to where we had a good working relationship. And eventually I got to run the tests that I wanted to run down there. [Laughs]

After about two weeks being down there and living night and day with these people, one Saturday morning the president of General Dynamics Fort Worth, chief engineer of the company, head of aerodynamics at that company, and Dr. Bob Laidlaw who was the Department of Defense F-111 Czar came down and asked me what the hell I was doing down there. So I told him what I was doing. And I said on that Saturday morning—I said "on Monday when we run another test, I'm going to run a configuration which is going to solve the problem on the engine stall at supersonic speeds." And I said—they said—"ok"—they didn't—the company didn't like me messing up with their wind tunnel program at all. I mean because they considered that was their own and they had brought the Department of Defense individual with them because they wanted a little support up at the DOD level. But I said you know "what the heck; [laughs] nothing ventured, nothing gained." So on Saturday—on Monday—night we ran that test, and it worked like a champ. Whew! So I called up the F-111 chief engineer at the SPO, the program director at the SPO; I called up the Dr. Laidlaw at D.O.D. and said "it works like a champ." And sure enough it did. And the contractor didn't like the solution because it meant that he was going to have to increase the external drag of the airplane; he's going to have to cut the wing spars and move them out four inches on each side, and that's a major change but you know, but if the engine's don't work the airplane isn't much good anyhow.

00:30:33 Pasi: Sure

00:30:34 Rall: So eventually, they tried other things in the flight test program other than that configuration, but eventually that's the configuration they went to. Then they

still had a problem sub-sonically. Engine would stall at high angle of attack. The lip-flow would separate over the inlet-lips going in. And so they went up to, they, the contractor went up to Hamilton-Standard wind tunnel in East Hartford Connecticut; and I think I was up there for about four or five weeks with them. And they couldn't get the results to match the wind tunnel test and the flight-test program. It didn't make any sense as to why they wouldn't match up. And the configuration that we were running was always the same cowl lip on the inlet. Cowl C-14, I'll never forget that; it's funny the things you remember. And finally, it wasn't my idea; it was the General Dynamics individual, Cal Porcher's, idea to check to see whether or not that the C-14 Cowl on this inlet model was the actual shape of the airplane. And it turned out it wasn't.

Oh my god, you know the light bulbs go off and here we were screwing around all these months and weeks doing things with the wrong configuration that didn't resemble the airplane. Put the airpl—put the—Got them to build the right configuration Cowl lip on it and now you could match up the flight test results with the inlet. That contractor didn't like that answer either because it meant the Cowl lips got fatter and that didn't help the drag any; it hurt the drag, but I mean again you've got to get the engines to run before anything else.

00:32:25 Pasi: Would you experience issues like these on all systems?

00:32:28 Rall: [Laughs] It's—I mean that's the fun part. [Laughs] The easy part is not the things you remember; the fun parts are the problem areas—the thing. [Laughs]

I'll give you as an example; when—on the B-70 program, while I was working it, I was out at North American in Los Angeles, and got called up one afternoon and said that Northrop was building this new airplane, the T-38 Trainer, and they were having a problem with the engine stalling, and would I go over there after work and see what was going on. I said "sure;" so I went over there and sat down with the Northrop guys and they got out—I'm the paper pusher kind of guy; I like to see the paper before I look at the hardware. And I got out the drawings; they gave me the drawings of the inlet. I calculated what the expansion angles were and what the turn angles were, and what the lip shapes were, and everything looked fine.

I couldn't see any reasons why the inlet should be a problem and then I noticed there was a gap between the inlet duct and the compressor face all along the circumference of the engine face. And I said "now what's that gap for?" And they said "that's where the compressor bleed air is dumped."

The compressor—in turbine engines frequently, when the engine is starting up—they—all of the little blades have a hard time operating at their design conditions, and so some of the air is bled off to reduce the back pressure and thrown overboard. This of course causes a loss in thrust when they throw the air overboard. So the contractor said instead of doing that, I'll just take the air and throw it back in front of the inlet where it will go back inside, so I don't lose that airflow, so therefore I don't pay that thrust penalty. What he didn't think was that that air that's coming off the compressor is hot, and so you got a temperature profile across that which effectively changes the angle of air going into the engine and that will solve it. And so I said you know just dump the air overboard. He said well you're going to lose thrust: I said "I know you're going to lose thrust: you'll lose more if the engines don't run." [Laughs] So the next day they threw the air overboard and it worked like a champ ever since. I mean those are the fun kind of things that you do.

00:35:15 Pasi: Problem solving.

00:35:16 Rall: Yeah, that's—I always was a problem solver.

00:35:20 Pasi: Well maybe going back to the F-111, you talked about some of the problems there. Just in the research I've done and what other peoples have said, that was a project that generated a lot of interest at the top levels of the Defense Department. Now that—was that unique to the F-111 or were all—

00:35:36 Rall: More—more unique than most. It was a program that was directed almost personally by the Secretary of Defense McNamara—not quite personally, but almost. He directed that the Navy and Air Force have certain amounts of commonality. I forget what the commonality definition was used, whether it was weight or part numbers, or something, but some kind of commonality. The Navy didn't want to buy didn't want to buy—didn't want the airplane. The Navy did everything it could to make the requirements such so that the airplane would be a failure. What kind of things did the Navy do? They insisted that the airplane have side-by-side seating rather than tandem seating. Side-by-side seating increases the width of the airplane, the fuselage; increases the drag and makes Mach number one point two at sea level very difficult to do. The Navy insisted that instead of having regular ejection seats; we have an escape capsule where the whole surrounding part of the fuselage be ejected with the pilot and navigator inside of it. That just makes the structure's weight go up drastically. [Laughs] They insisted that this capsule, which was going to float in the ocean after it landed, have a sump pump in it so that the sump pump would push the stick back

and forth and pump the water out of the thing if it leaked at all. They [laughs] did lots of things to discourage the actual airplane.

On that program I met George Spangenberg; George Spangenberg turned out what was my equivalent that later on—he was essentially the tech director of Naval Air Systems Command, really a good guy. Although he and I didn't agree as far as the desire to get the airplane to function correctly, we never disagreed on really technical subjects is the way it was.

You know they could defend their position about how high lift-devices have to be for carrier take-off and landing. They insist that they're the only ones who know how to worry about the aircraft carrier compatibility of the airplane. And it's hard to argue with that; you can't argue. So eventually we didn't win that argument as far as the Navy buying the airplane at all.

But it was because of this continual conflict back and forth, with the Navy and Air force, that the Department of Defense was really involved in doing this. And this was going to be a new way of doing business with the Air Force, I mean with the Department of Defense showing how we could efficiently run the development program rather than having these independent services build our own individual airplanes.

I should point out of course that the F-14 which is later, which the Navy built, didn't have an escape capsule; had ejections seats. Didn't have side-by-side seating; had tandem seating, etcetera, etcetera, so it was clear what the navy's intention was.

00:39:33 Pasi: They were trying to—

00:39:34 Rall: Yeah. The admiral—we had an admiral that was the number two in the SPO, System Program Office. One day the admiral called me into his office and said “Fred would you analyze the flight test data to see what the performance of the airplane was?” I had been doing a whole lot of other things, so I said “yeah;” I went back and got my guys to start working and analyzing the flight test data to see what the performance was going to be. And we put that flight test performance data package together and handed it to the—and this is on the F-111A; it wasn't on the Navy airplane at all—and handed it to the Admiral without telling the General who was in charge of the program what it is we were doing. That was a mistake. That was not a very smart Fred. But what it would have showed was that the airplane was not meeting its specification requirements.

Back up a little bit. The Department of Defense had gone through three separate competitions in order to arrive at the final contractor selection, General Dynamics Fort Worth. Each one of these competitions does nothing except encourage the contractors to exaggerate their claims even more and more, and more, and so I mean it's built into the various designs that you are not going to be able to meet the performance requirements that were in the specifications. I don't remember what the exact numbers were but they went something like this. Contracts specifications said that the ferry range of the F-111A should be something like forty-two hundred nautical miles. And what we showed the flight test data was doing was something in the order of thirty-six hundred or thirty-seven hundred nautical miles. So it's a significant difference. Needless to say when the Navy saw this they were quite happy. [Laughs] Needless to say when the General in charge of the program office saw it he was very unhappy. [Laughs] So not knowing what to do, my chief engineer in the program called up the Scientific Advisory Board and had the Scientific Advisory Board—Air Force Scientific Advisory Board—come in and review the work that we had done. So I gave them a briefing for four, or five, hours on analyzing the flight test data and they agreed with the work I had done, which was a great disappointment to the general needless to say [laughs], and didn't have anything they could do. At this time the general was forced to take that information up to headquarter USAF and report it. And that didn't cause much joy up there either.

If I remember correctly, I forget who the Secretary of the Air Force is at that time; I think it was Harold Brown at that time. And I remember going through the briefing and telling him. I mean there was one unhappy individual because he was going to have to talk to the Department of Defense, and he knew they weren't going to be very happy either.

But I mean the facts are the facts; and so you—I'm just the poor dumb engineer and I just say it the way it is. I got back to the office after going through the briefing; I got a call down to the General's office. I got called up a lot, [laughs] and said "Fred it was nice having you on the inside of the program, too bad it's not going to happen any more, good bye." Well that didn't go over very well with me. [Laughs] And so I was really unhappy; I was in the process of going through a divorce in my first marriage at the time anyhow. So I mean here I am in reasonably poor shape. As I was reading a Wall Street Journal I noticed an ad that North American Aviation, Columbus, who was building the Navy A3J airplane, was looking for a head of aerodynamics. And I said "ah, what the hell Fred, you know, [laughs] put in an application maybe this'll solve all your problems; you don't have to worry about it." So I put in my application; went out

and interviewed over there. And came back and got a letter in the mail; they'd offered me the job. [Sighs] I didn't know; that caused me a problem because now I have to make a decision. Well I got to thinking about it; I said "you know what you're really doing is you're running away from the problem...you're afraid to face it." And I said "Fred if you don't face up to it now; you know you never will; don't run away; just stand up and take it on." And so I did.

That little episode about the performance and the North American job offer was before I resolved the problem with the engine inlet compatibility. And so then I'm happy to say that the General—I was back in the General's good graces after that resolution. And as a matter of fact when he eventually got up to Systems Command Headquarters in Washington he got me to be the AFSC nominee for the Collier trophy for that year. That was poor timing on his part because that year the Collier Trophy was given to the guys who first flew around the moon. So [laughs] I had a lot of competition.

00:45:50 Pasi: Bad Year.

00:45:51 Rall: Yeah.

0045:52 Pasi: Well Mr. Rall, you talk about problem solving, working between the contractors and the Air Force. Again your friend General Stewart said that one of the best decisions he ever made in his career was making you the Deputy Director for Engineering at the ASD. He said you developed a sys—I want to get this right—you developed a—forgive me—a "structured approach to aviation development." That's what he said—"a structured approach to aviation development." You developed that. What is a "structured approach to aviation development" and how is it different from what had gone before?

00:46:47 Rall: Development has as a foundation what your objectives are. You've got to have well defined objectives. Those objectives have to be consistent with the technical state of the art; they have to be doable in the schedule that you've allocated. And they have to be doable within the cost constraints that you've got. If you don't have those then you don't have a good foundation and the program is going to run itself into trouble.

Now that's easy to say, but that's harder to do because involved in getting those objectives together are a large number of organizations loosely connected. There's the using command. There's the training command. There's a maintenance command. There's the acquisition command in my day. There's the headquarters, USAF, people. There's the Department of Defense people. There's congress and eventually even the executive department to some degree. They all

have to agree as to what these objectives are. And that—I mean that is a fundamentally difficult thing to do. If you don't have those though, you really got yourself a problem.

When I became—when I got involved with the F-15 program, later on after the F-111, there were several decisions which had to be made to discern what the objectives were. You had to decide whether you wanted one-man or two-man crew. There was a lot of arguments for people who wanted two men and one for one-man. And we did a lot of technical evaluation back and forth of what the cost was, size of the airplane impacts were, etcetera. And when push comes to shove, it came down to the pilots making the decision that they didn't like the guy in the backseat telling him what to do; so they opted to go for one man. And so we got that decision made.

Another option was “are we going to go for two engines or one engine.” One engine significantly reduces the cost of the size of the airplane, but it has the problem of it, if you lose an engine you might well lose the airplane. And a lot of people had flown F-4s in Vietnam, and had come home with one engine shot out and one engine operating. So the decision was made to go for two engines.

Another decision was whether how fast the airplane had to go—what the maximum speed was going to be. I got called in one time to go to Neal Armstrong's office when he was in NASA in a job up there. He was trying to push Mach 3 because the Langley people could do a lot of research that would help get that airplane going underway. But the decision—we did lots of technical work, lots of tradeoffs, lot of company involvement, lot of government work involved as to what the cost was. Finally one afternoon in the Pentagon, in the Secretary's conference room, we had more generals with stars on than are in the heavens; I mean you wouldn't believe the number of stars that were in there. And the subject was what's the max speed going to be? And the Chief of Staff of the Air Force made it very simple. He said “Mach two and a half is the lowest Mach number I can sell to congress, so that's what we're going to do.” Well that was alright by everybody because for a mach two and a half airplane it's only a temporary speed and you can still build it out of aluminum; you don't have to go to steel and titanium and increase the cost.

Another problem—another objective—was how big an airplane you going to build? At the time that we were considering putting together the fundamentals of the requirements for what turned out to be the F-15 airplane, the Navy was pursuing the F-14. Our preliminary studies showed that our airplane, to meet the requirements that we had come up with, looked very similar to what the Navy



airplane F-14 turned out to be—swing wing, same weight category sixty-thousand pounds, etcetera. So the decision was made by the “blue-suiters” that said “ok we can’t afford to have two airplanes looking similar again as we did on the F-111 airplane.” So the decision was made “we’re going to have an airplane which weighs no more than forty thousand pounds period.” That set the foundation.

Now at the same time that it was said that, they made the statement that “and there will not be a pound for air to ground” meaning “we don’t want to have any bombs hanging on it; we don’t want—anything—any compromise made to the air-to-air combat capability of this airplane for air-to-ground.” Well we said “we stand up and salute a lot, but there are some things you know that you got to—you got to sort of bend what the military is telling you.” So we invented a “ferry mission.” A ferry mission is how you’ll go from Langley to Bitburg over in Germany non-stop without getting refueled, which created a requirement for three six-hundred gallon external tanks, which later could be used to put armament on—bombs if you wanted to etcetera, etcetera. And so we bent the rules a little bit by creating this ferry mission, which you know they didn’t know what we were doing, but that’s ok. We did that a little bit on the avionics and the radar as well, so you have to have a little flexibility there. So getting that fundamental base is important.

Next, you’ve got to establish a set of technical milestones; you’ve got to have milestones which say that you are making your desired progress down the way. These technical milestones can consist of complete wind tunnel test number “umpty-ump,” or a static test, or preliminary design review, etcetera. But you’ve got to have these milestones dictated, and you’ve got to be in the contract so that if necessary you can call the program to a stop. That’s really critical to do—is to have the technical milestones.

Next you have to find someway to guarantee that you are not held to the level of performance that the contractor will propose in his proposal because he’s in a competition, and he’s going to bend every rule in a positive direction you can get. And hundreds of competitions that I’ve been in, I mean the contractor has never been pessimistic in what his airplane will do—never been. So what we did in the F-15 program was develop—have—a development concept paper, which was essentially a separate contract between the SPO and Washington D.C. in which we said “here is our performance we say we’re going to achieve and not the performance that the contractor gave us in his proposal.” We are forced to put those numbers into the contract that the contractor proposed; that’s just the way the contractual people go. But we had a separate contract as far as performance,

so you've got to recognize that that exists otherwise you're going to be in problem later on.

Then you want to incrementally do the PDRs and CDRS, Preliminary Design Reviews and Critical Design Reviews. Ordinarily these are big gaggle of get-togethers; people come in from all of these different agencies and they sit around, and they mull over things for days and they say "oh, I don't like this," and "I don't like that" and "I don't like this." And "why don't you do it this way?" And so—rather than avoid that—rather than to have that kind of an outcome, you institute incremental PDRS, so that you do them time wise well ahead, a little bit at a time, a little bit at a time, so everybody gets their input in that always so that by the time you get to the final, official, Preliminary Design Review or Critical Design Review, the whole thing is a forgone conclusion and there's really, everybody's a big disappointment because there's no big arguments and no big surprises. I mean that's important to have happen.

Another thing you do is you recognize that people from the outside are always going to be trying to get involved to some degree. So you establish independent, multi-agency, review teams which you make part of the team. Boy, you get people from the laboratories, you get people from NASA, you get people from—what'd I say—the Army, or the Navy, wherever somebody could contribute. And you make sure that they're a part of the team, even beginning at the thing so you get them involved. And you do that for each of the technical disciplines, so that there's some NASA individual comes around and say "man you know how come we haven't been told that?" you can say "Joe blow from NASA said this and thus, and so I mean you're already involved." And you do that and sometimes they give you good tips.

00:58:14 Pasi: Mr. Rall I don't mean to interrupt you, but I do think we're running out of time, today. Hopefully this will be the first of a few interviews we can do for you because I feel like we've only scratched the surface.

00:58:23 Rall: [Laughs]

00:58:25 So, to my detriment here I think we have to bring this to a close, and I just want to say we've enjoyed doing this with you and again hopefully this will be the first of several.

00:58:38 Rall: [Laughs] I didn't know I could talk this much. [Laughs]

00:58:42 Pasi: Thank you for being with us and maybe we can pick up this discussion of how systems go from idea to system again.

00:58:50 Rall: Ok

00:58:50 Pasi: Thanks very much.

00:58:51 Rall: Right, you're welcome.

End of Video Tape 2.